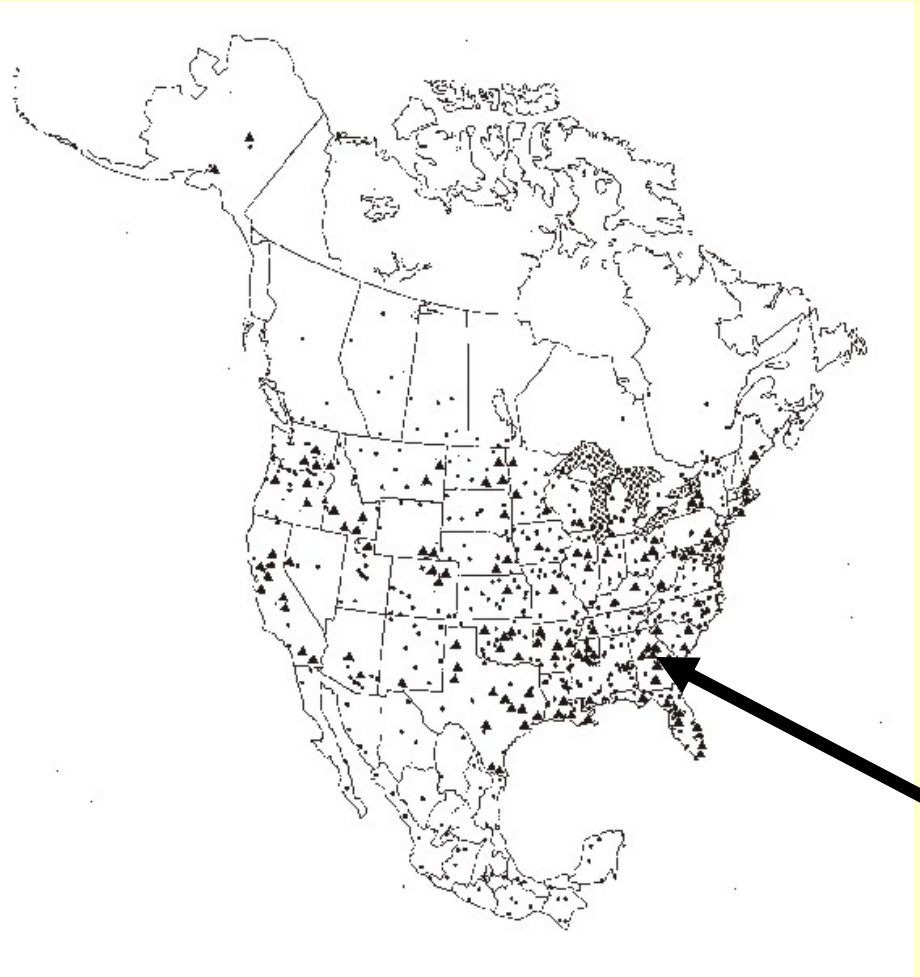
Yield and Soil Properties in Two Crop / Grazing Rotations under Inversion and No Tillage



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Rationale

- ✓ Integration of crops and livestock could provide benefits to production and the environment
- ✓ Soil organic matter is a critical component in maintaining soil quality
- ✓ Permanent pastures are known to improve soil organic C and N
- ✓ Cropping systems in rotation with pastures have not been evaluated in detail
- ✓ Climatic conditions (i.e. spring vs. summer cropping) could modify success of a system

Objective

- ✓ Quantify plant and animal productivity and measures of soil quality in response to three management factors:

  - Tillage
    (a) conventional tillage and (b) no tillage
  - Cropping system
    (a) summer grain – winter cover crop (SGWC)
    (b) winter grain – summer cover crop (WGSC)
  - Cover crop management
    (a) unutilized and (b) grazed by cattle

Hypotheses

- ✓ Tillage:
  - ***Yield*** not affected by tillage
  - ***Soil*** properties better with NT than CT
- ✓ Cropping system:
  - ***Yield*** potential higher in summer due to higher temperature, but yield variability greater in summer due to less consistent precipitation
  - ***Soil*** more compacted with grazing in winter
- ✓ Cover crop:
  - Crop ***yield*** reduced with grazing due to compaction and less surface residue, but overall yield potential higher due to animal gain
  - ***Soil*** properties better without grazing

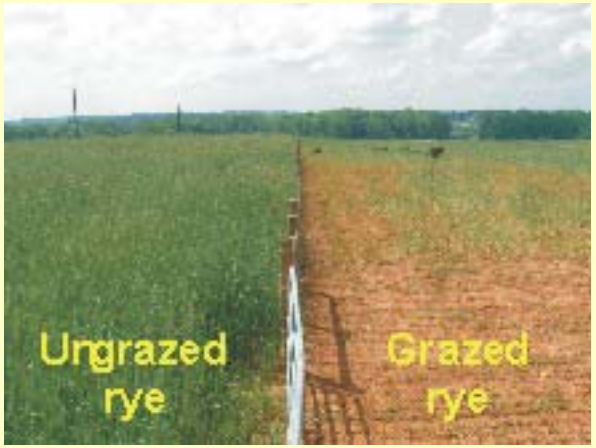
Methods

- ✓ Set of 18 paddocks (0.7-ha each) previously in tall fescue for 20 yr on Cecil sandy loam
- ✓ 4 replications of 8 treatments after paddocks split into grazed (0.5 ha) and ungrazed (0.2 ha) areas
- ✓ All crops received 40 kg NH_4NO_3-N ha^{-1}
- ✓ Grain yield from entire paddock
- ✓ Yearling steers 1st year; cow/calf pairs 2nd year
- ✓ Production results from 2002/03 and 2003/04
- ✓ Soil collected (4-cm diam) from composite of 8 or 5 cores
  - Initiation, end of Year 1, end of Year 2

Methods

Summer Grain – Winter Cover Crop
SGWC – (sorghum / rye)

Crop component	Cover Crop: Unutilized		Cover Crop: Grazed
	------- *Mg ha^{-1}* -------		
Rye stover	7.4	>>>	0.6
Sorghum grain	2.3		2.2
Sorghum stover	3.7	>	3.0



Summer Grain – Winter Cover Crop
SGWC – (sorghum / rye)

Crop component	CT		NT
	------- *Mg ha^{-1}* -------		
Sorghum grain	2.3		2.2
Sorghum stover	2.5	<<	4.2
Rye stover (ungrazed)	7.0	<	7.9

Animal component	CT		NT
Stocking rate *(head ha^{-1})*	6.6	<	9.3
Animal gain *(kg ha^{-1})*	294	<	485
Calf daily gain *(kg head^{-1} d^{-1})*	1.02		1.09

Winter Grain – Summer Cover Crop
WGSC – (wheat / pearl millet)

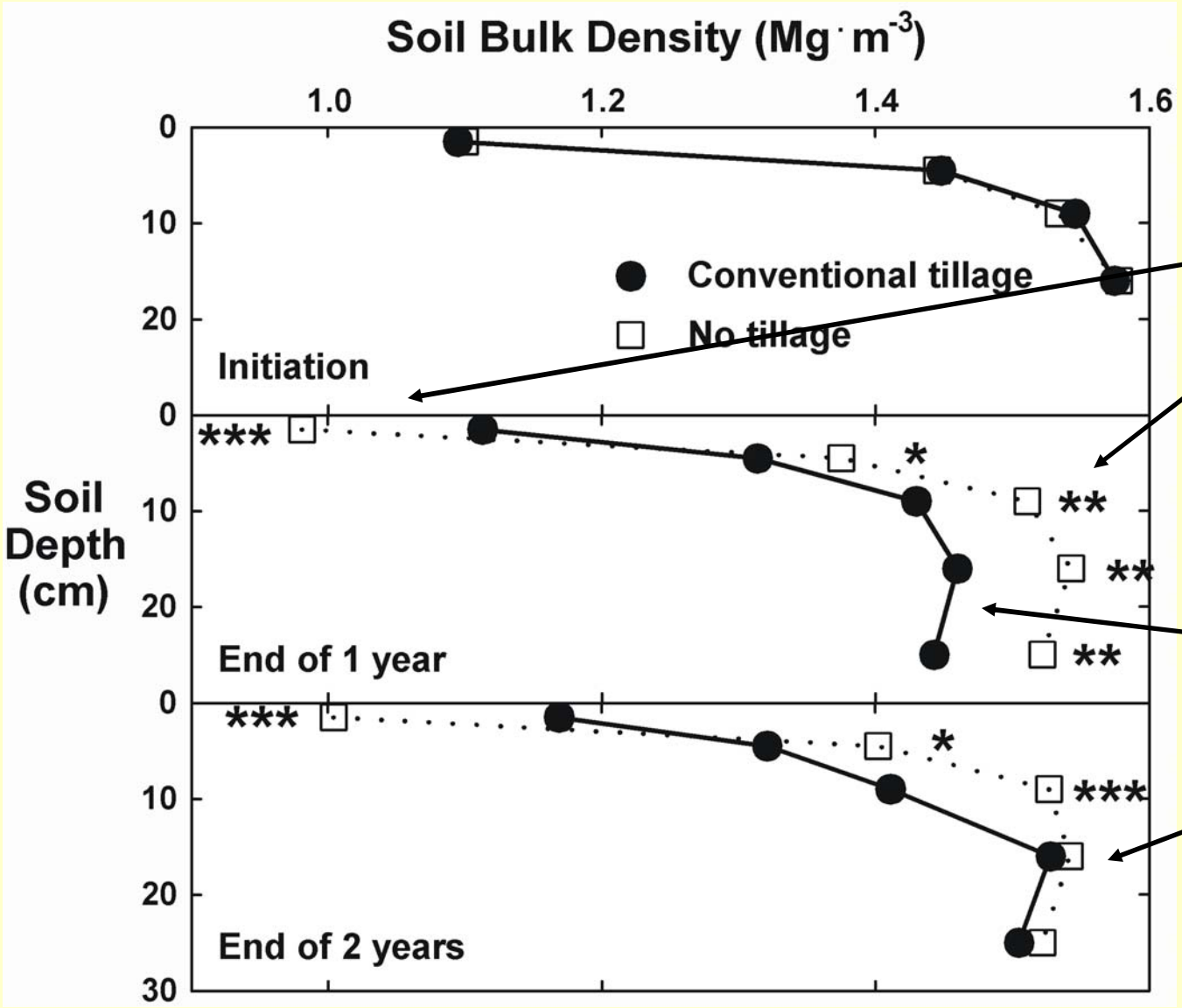
Crop component	Cover Crop: Unutilized		Cover Crop: Grazed
	------- *Mg ha^{-1}* -------		
Millet stover	10.7	>>>	1.0
Wheat grain	2.1	<<	2.5
Wheat stover	1.1	<	1.3

Winter Grain – Summer Cover Crop
WGSC – (wheat / pearl millet)

Crop component	CT		NT
	-------- *Mg ha^{-1}* --------		
Wheat grain	2.4		2.2
Wheat stover	1.1	<	1.3
Millet stover (ungrazed)	8.9	<<	12.5

Animal component	CT	NT
Stocking rate *(head ha^{-1})*	7.3	7.0
Animal gain *(kg ha^{-1})*	404	433
Calf daily gain *(kg head^{-1} d^{-1})*	0.93	1.05

Soil Bulk Density



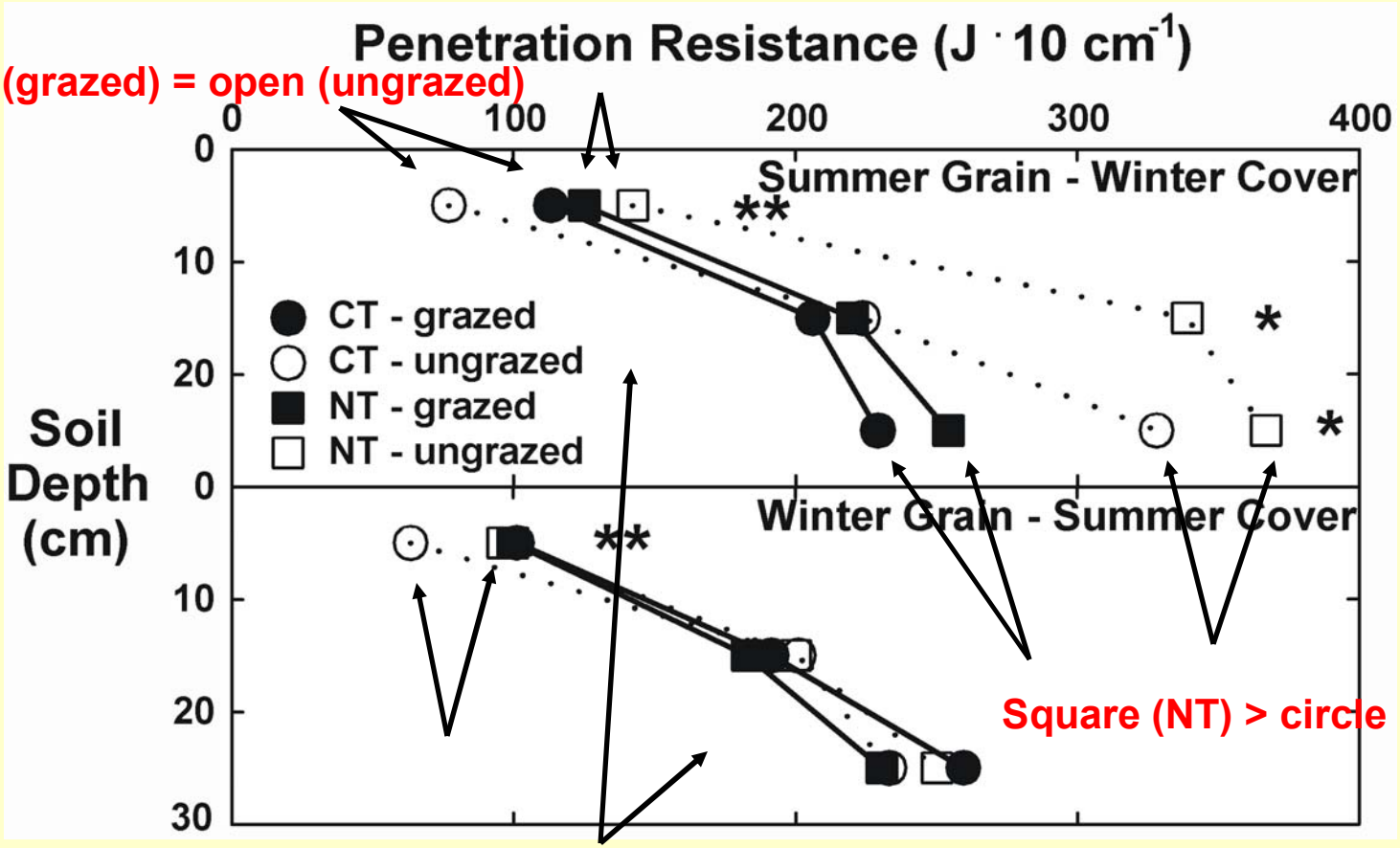
Soil under NT remained highly stratified with depth

- Low BD at the soil surface
- High BD > 6 cm

Moldboard plowing loosened soil initially following tillage

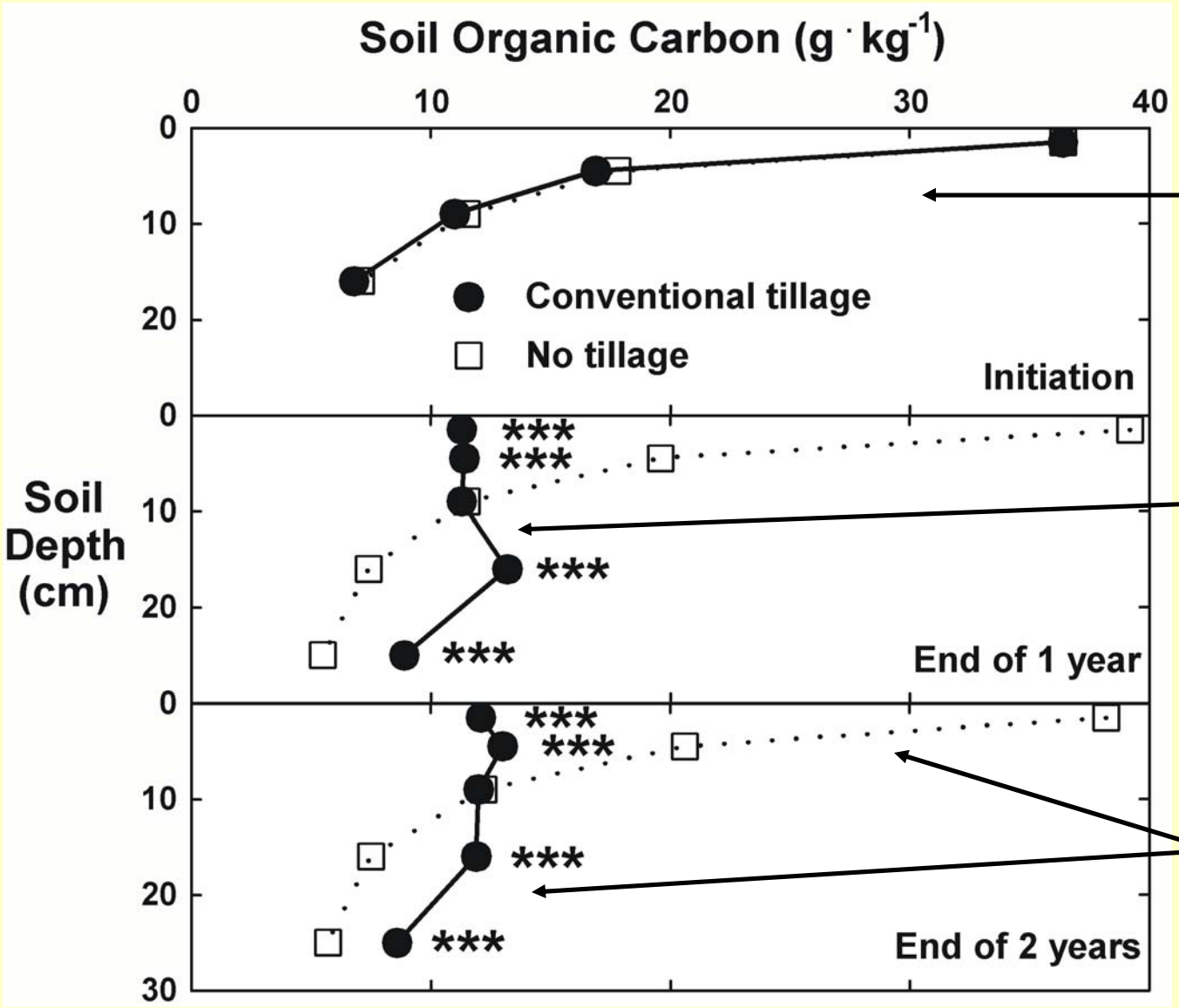
- However, at 2 years, BD was high >12 cm

Penetration Resistance



- ✓ Soil resistance tended to be higher under NT than under CT
- ✓ Soil resistance was not adversely affected by cattle traffic with cover crop
- ✓ Surface soil resistance tended to be only slightly higher with winter grazing compared with summer grazing

Soil Organic C Concentration



Initially high surface C

Following inversion tillage, soil organic C became relatively uniformly distributed with depth

Soil organic C with NT was greater than with CT in the surface 6 cm, but lower than with CT below 12 cm

Stock of Soil Organic C

	Soil		Surface Residue	
Time	CT	NT	CT	NT
0-20-cm depth	---------- *Mg C ha^{-1}* ----------			
Initiation	37.9	39.2	1.7	1.7
End of 1 yr	33.2 <<	38.9	0.2 <<<	2.2
End of 2 yr	33.9 <<<	40.2	0.5 <<<	4.0

✓Carbon was immediately redistributed within the soil profile with CT, but not greatly mineralized

✓Surface residue C was lost with CT, but accumulated with NT

✓At the end of 2 years, total C stock (soil + residue) under CT was 5.2 Mg C ha^{-1} lower and under NT was 3.3 Mg C ha^{-1} higher than initial C stock (21% difference from initial level of 40.3 Mg ha^{-1})

Integrated Agricultural Evaluation

Animal Production

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Crop Production

Soil Quality

- ✓ An integrated agricultural evaluation with profit, production, soil, and environmental considerations is planned at the end of 3 years

Conclusion

- ✓ Grazing of cover crops can increase production opportunities without negatively affecting soil quality

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